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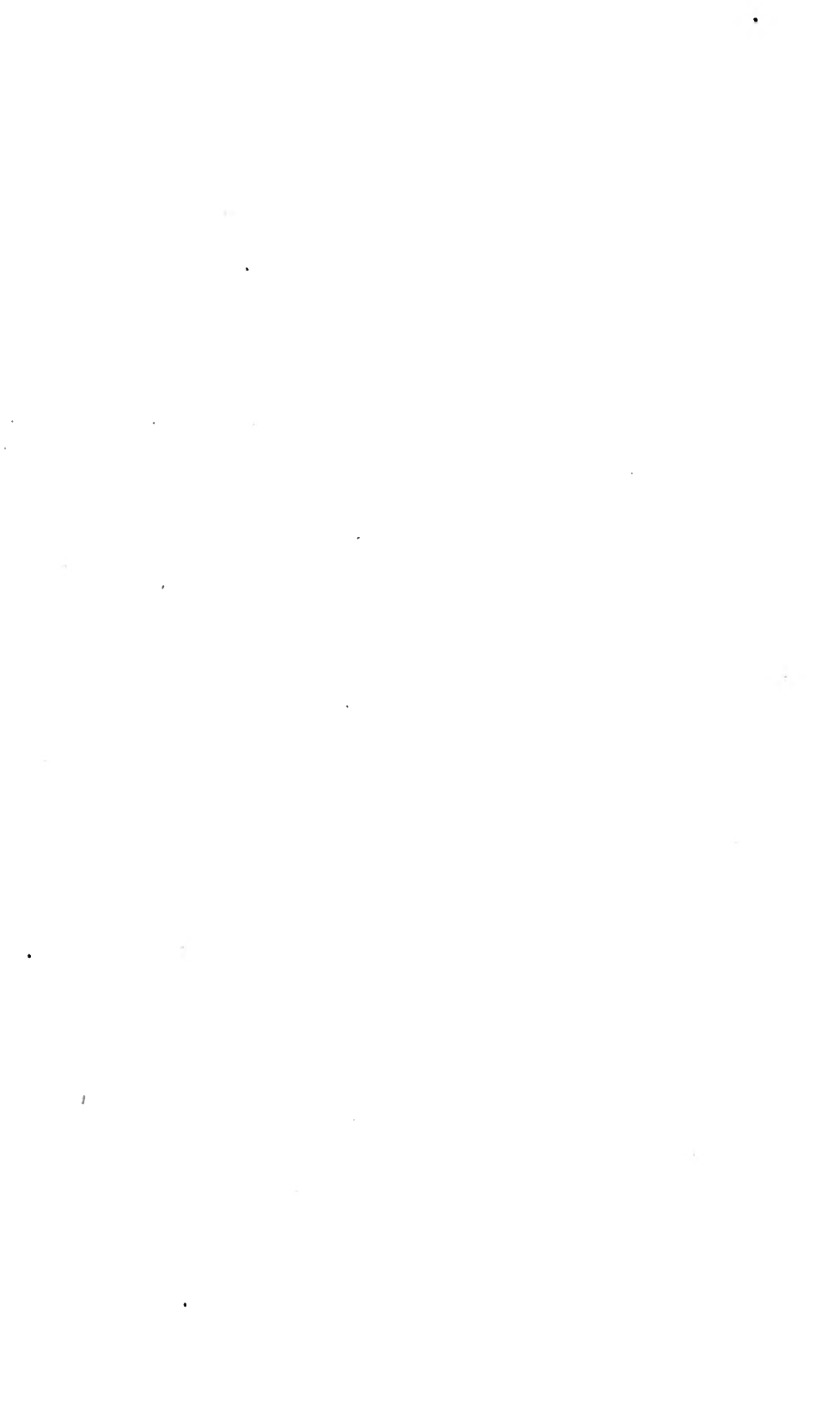
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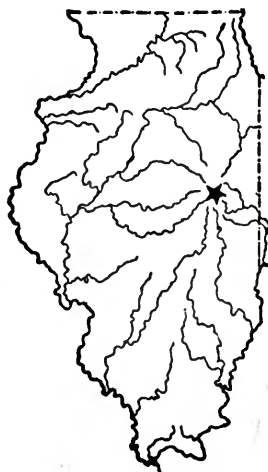
Agricultural Experiment Station

BULLETIN No. 106

SPRAYING APPLES

Relative Merits of Liquid and Dust Applications

By CHARLES S. CRANDALL



URBANA, ILLINOIS, FEBRUARY, 1906

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SPRAYING APPLES

Relative Merits of Liquid and Dust Applications

By CHARLES S. CRANDALL

No problem is of more direct and vital interest to the owner of an apple orchard than that relating to the repression of injurious insects and fungi. Borers, twig-girdlers, canker, and blight attack the trees. Canker worms and scab defoliate. The fruit is infested with curculio and codling moth, or is destroyed by bitter rot, or is defaced and rendered unsalable by apple scab and blotch.

It has been the experience in every fruit-producing region that pioneer orchards were free from injurious insects and fungi during their earlier years; that, later, injuries by insects or fungi, or both began to appear and that, as orchard areas increased, the injuries multiplied until crops were ruined unless protected by the persistent application of means of repression. Except for small isolated regions in the far west the country has passed the pioneer stage in fruit-growing. For most sections the business is comparatively old; pioneer plantings have disappeared and present orchards belong to the second, or even to the third generation of orchards. Insect enemies and injurious fungi have had time to become widely disseminated and thoroughly established.

It may be assumed that these pests are here permanently and in the planning of any fruit-producing enterprise they must be considered and dealt with as one of the important factors.

These orchard enemies are not equally abundant or equally destructive in all sections, nor are the attacks uniform in all seasons. Most of them range in cycles; there are periods of excessive abundance followed by years of comparative scarcity, but the year of abundance of one insect may be the year of scarcity of another; the cycles of different species vary in length, so that it is hardly possible to predict which enemies will preponderate in any particular year.

Weather conditions play an important part and in great measure govern the abundance and destructiveness of both insects and fungi. It is evident from the nature of the injuries inflicted by both insects and fungi that these injuries can not be cured. Leaves that have been eaten can not be restored; the worm that gains access to the

interior of a fruit is safe from molestation except by destruction of the fruit. Vegetative portions of most fungi are within the tissues of the plant beyond reach of destruction except by destroying the containing tissues. It is therefore perfectly evident that measures of repression directed against both insects and fungi must be entirely preventive and not curative. Full appreciation of this fact is essential to the successful and economical application of remedies and it is suggested that every orchardist should make himself familiar with the life histories of the insects and fungi he may find it necessary to combat; there is satisfaction in knowing these things and the knowledge is essential to intelligent action. It is true that full information is not at hand for all insects or all fungi, but the more common and most destructive are pretty well understood, and information regarding them is easily obtainable. The more complete the knowledge of the enemy the easier it is to plan a campaign and the greater is the possibility of success. Some orchardists appreciate the truth of this proposition and are successful in practice. There are others who do not appreciate it, whose ideas of the orchard enemies they would fight are very hazy and whose haphazard practice is not successful.

Although insects and fungi have been doing enormous injury to fruit crops for many years, it is only within a very recent period that means of repression have been reduced to anything like effective system. Many years ago in the older fruit regions numerous substances or compounds that by reason of strong odors, caustic or poisonous action, were supposed to be destructive to insects, were applied to plants in a small way, either in the form of dry powder, or in liquid form sprinkled on with a garden syringe. Sometimes these applications were reported successful, but more often they failed to accomplish the desired result. Arsenic in some form was used quite early, but its very poisonous nature raised objections which were difficult to overcome and there was the additional disadvantage that it invariably proved injurious to foliage. The advent of the Colorado Potato Beetle brought compounds of arsenic into common use. It was necessary to kill the beetles, the arsenic compounds proved most effective and soon they were in great demand. No ill effects were experienced; people became accustomed to the use of the various compounds and from successful use on potatoes, applications to all kinds of plants for the repression of all kinds of chewing insects followed in easy sequence.

All the arsenic compounds were more or less injurious to foliage and this was a great objection to their use. In 1889 Professor Gillette found that the addition of lime to compounds of arsenic greatly

reduced the injury to foliage. This discovery was quickly adopted in practice and marks the general acceptance of arsenic in some of its compounds as the best destroyer of chewing insects.

In the fall of 1882 the discovery was accidentally made by Professor Millardet at Bordeaux, France, that a mixture of copper sulphate solution and lime applied to foliage would prevent development of grape mildew. This discovery led Professor Millardet to inaugurate experiments in 1883 which were continued until, in 1885, he gave out the first definite formula for compounding copper sulphate and lime, forming what has since been known as Bordeaux mixture. This first formula was soon modified considerably as to proportion of ingredients and its use was extended until it came to be accepted as the sovereign remedy for most of the fungi attacking fruit plants. The first means of applying Bordeaux mixture were very crude and attention was soon turned to improvement in this direction. When comparison is made between the appliances in use today and those in use fifteen or twenty years ago, it becomes evident that the evolution of methods of application has been rapid.

Spraying has become a permanent factor in fruit-growing and is recognized as one of the essentials of good orchard practice. The development of spraying has been rapid, but perfection has by no means been reached. There is yet much to be learned regarding the relative efficiency of various formulæ and many improvements are to be expected in the mechanical means of application and in details of practice that will diminish the cost and increase the effectiveness of spraying. By common consent water has been the medium used for distributing the copper and arsenic compounds. Spraying with liquid has been the universal practice. A few years ago it was suggested that the compounds used in spraying should be applied in a dry way, using dry-slaked lime as the conveyor and dusting the trees by means of a strong air blast. Naturally the two methods, spraying with liquid, and dusting, suggested questions regarding the relative merits of the two. Which is the cheaper? Which the more easily applied? Which is more effective?

These are practical questions and correct answers are of importance to those engaged in fruit-growing. The demands upon the Experiment Station for definite answers have been numerous enough to show a widespread interest in the matter.

Some of the men propounding these questions made more or less extensive tests of the two methods in their own orchards in 1902 and preceding years. As a result of these tests some gave approval to the dusting process, some gave unqualified condemnation, while others were in doubt. All were anxious for more light regarding

this matter. Accessible printed information on the subject is not extensive. There are some articles in horticultural periodicals lauding the dusting process as the only panacea for orchard troubles, other articles holding that only liquid spray is effective, and still others that discuss the subject pro and con without definite commendation of either method. There have been no reports of definite and careful experiments testing the two methods upon contiguous blocks of trees with adjacent checks.

Statements of results which are based upon general impressions of any given treatment, especially when no control trees are maintained for comparison, do not satisfy; the mind of the observer may lean a little in one direction or the other, and, perhaps unconsciously, he fails to overcome that natural tendency to see what he wishes to see. Such reports always leave openings for question and doubt.

In order to compare the efficiency of two methods of treatment of orchard trees for insect injury and the ravages of fungous diseases, the methods in question must be tested side by side under conditions as nearly alike as it is possible to make them. There must also be proper control trees which shall be conditioned as are the other trees in everything except the particular treatment under investigation. Observations must be frequent, records full, careful and continuous, and observed phenomena must be correctly interpreted. This implies much labor, the exercise of patience, and the use of good judgment, but results obtained in any other way do not warrant definite conclusions.

EXPERIMENTS UNDERTAKEN

In response to the popular demand for information the horticultural department of the Experiment Station undertook certain experiments designed to test the relative efficiency of the two methods of applying spray materials. The experiments were commenced in 1903 in the orchard of Mr. W. C. Reed four miles south of Olney. This orchard was chosen because conveniently near other experiments then in progress and because it offered a fairly even block of one variety that had never been treated with any kind of spray. The five west rows of this orchard containing a total of 108 trees were used in the experiment. The trees of the two west rows were at this time 18 years old, those in the other rows 17 years old. There was no appreciable difference due to this difference in age, but all the trees at the north end of the block were noticeably larger than were the trees of equal age at the south end. This variation in size was most probably due to some difference in the soil. The

ORCHARD OF MR. W. C. REED.

Experiments testing the relative merits of liquid spray and dusting.

Plat No. 1—Liquid	0	0	0	0	0
	0	0	0	0	0

Check row No. 1	0	0	0	0
-----------------	---	---	---	---

Plat No. 2—Dust	0	0	0	0	0
	0	0	0	0	0

Check row No. 2	0	0	0	0	0
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Plat No. 3—Liquid	0	0	0	0	0
	0	0	0	0	0

Check row No. 3	0	0	0	0	0
-----------------	---	---	---	---	---

Plat No. 4—Dust	0	0	0	0	0
	0	0	0	0	0

Check row No. 4	0	0	0	0	0
-----------------	---	---	---	---	---

Plat No. 5—Liquid	0	0	0	0	0
	0	0	0	0	0

Check row No. 5	0	0	0	0	0
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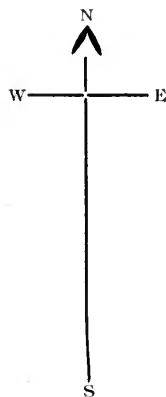
Plat No. 6—Dust	0	0	0	0	0
	0			0	0

Check row No. 6	0	0	0	0	0
-----------------	---	---	---	---	---

Plat No. 7—Liquid	0	0	0	0	0
	0	0	0	0	0

Check row No. 7	0	0	0		
-----------------	---	---	---	--	--

Plat No. 8—Dust	0	0	0		
	0	0	0		
		0	0		
	0	0	0		



larger size of the trees at the north end brought them into close contact so that the lower branches interlaced. Some pruning was done to correct this, but only enough to admit free passage in cultivating and spraying. The block was divided into eight plats of two rows each, and seven rows, one between each two plats, as control or check trees. Plats 1, 3, 5, and 7 were scheduled for treatment with Bordeaux mixture applied in liquid form, while the alternate plats numbered 2, 4, 6, and 8 were to be treated with Bordeaux applied dry, as dust. Owing to vacancies the number of trees in the plats was not quite uniform, but the total in each set was the same, namely 38, with 32 trees in the seven check rows. The arrangement of plats is shown in the diagram, page 211.

The plan of operations decided upon was to treat the four plats numbered 1, 3, 5, and 7 with Bordeaux mixture and Paris green, using what is known as the "standard formula," which is, 4 pounds of copper sulphate, 4 pounds of lime, $\frac{1}{4}$ pound of Paris green and 50 gallons of water, and to treat the alternate plats numbered 2, 4, 6, and 8 with the "Dry Bordeaux and Paris green" preparation manufactured and sold by the "Dust Sprayer Manufacturing Company," of Kansas City, Missouri. This material was to be applied with one of the "Cyclone" machines made by the same company. The prearranged schedule of applications was as follows:

Plat No. 1 liquid and Plat No. 2 dust. Three applications.

1—as buds are bursting.

2—after petals have fallen.

3—one week later.

Plat No. 3 liquid and Plat No. 4 dust. Five applications.

1—as buds are bursting.

2—after petals have fallen.

3—one week later.

4—date intermediate between application No. 3 and July 10.

5—July 10.

Plat No. 5 liquid and Plat No. 6 dust. Seven applications.

1—as buds are bursting.

2—after petals have fallen.

3—one week later.

4—on date intermediate between application No. 3 and July 10.

5—July 10.

6—July 24.

7—August 7.

Plat No. 7 liquid and Plat No. 8 dust. Eight applications.

1—as buds are bursting.

2—after petals have fallen.

3—one week later.

4—on or about June 15.

5—ten days later or June 25.

6—ten days later or July 5.

7—ten days later or July 15.

8—ten days later or July 25.

The seven check rows containing 32 trees were to receive no spray whatever.

Owing to weather conditions, the first application planned to be given as buds were bursting was omitted and the first application was made just after the petals had fallen. With this exception the schedule was followed closely and the plats, instead of receiving 3, 5, 7, and 8 applications as planned, received only 2, 4, 6, and 7 applications respectively. The actual dates of application were as follows:

	Liquid plats.				Dust plats.			
	No. 1.	No. 3.	No. 5.	No. 7.	No. 2.	No. 4.	No. 6.	No. 8.
April 30.	1	3	5	7				
May 1.					2	4	6	8
May 8.	1	3	5	7	2	4	6	8
June 6.		3	5			4	6	
June 15.				7				8
June 25.				7				8
July 6.				7				8
July 10.		3	5			4	6	
July 15.				7				8
July 25.			5	7			6	8
August 7.			5				6	
Times sprayed.	2	4	6	7	2	4	6	7

In making the first application the liquid was applied late in the afternoon of April 30 and the dust early in the morning on May 1.

Subsequent applications were completed the same day, and the practice was to apply the dust very early in the morning, between the hours of 4 and 6, while the dew was still on and before wind arose; the liquid applications following later in the day. In applying both liquid and dust preparations great care was exercised to do the work in the most thorough manner possible. While effort was made to confine the applications to the trees for which they were intended, there was, on two or three occasions, some unavoidable drift of material to adjoining check trees. This was especially the case in applying dust, but it is not thought that this drift was sufficient to influence greatly the results.

It was the intention to gather all fallen apples at frequent in-

tervals and record the defects found on them, but because of insufficient assistance for all work at hand, it was found impossible to do this and no fallen fruit was gathered and examined until September 1, except that all fallen apples affected with bitter rot were collected and recorded from and after July 27. These fallen apples having bitter rot were gathered July 27 and 28, August 8, August 20 and August 27.

The first of September a general gathering of all fallen apples was made; this included also those fruits having bitter rot. This procedure was repeated September 11 to 14 and again October 16 to 23.

The final picking of fruits from the trees was commenced October 16. The plan followed was, first to gather the fallen fruit of one plat or one check row, examine each apple and make the record; then pick the fruit of that plat or check row, examine and record in the same manner. Because this plan was followed, the dates of the last gathering of fallen apples and the dates of final picking run along together from October 16 to October 23. On this latter date the work was completed.

APPARENT EFFECTS OF THE APPLICATIONS

Foliage.—During the month of July differences between plats became apparent. It was particularly noted by all who visited the orchard that the foliage of the trees upon the liquid sprayed plats was of darker color and generally of more healthy appearance than the foliage of dust sprayed and check trees. This difference in appearance of foliage was due, in the main, to apple scab, which continued to develop on the leaves of dust sprayed and check trees, while its growth had been in great part arrested or prevented on leaves of the liquid-sprayed trees.

Early in August leaves began falling from dust-sprayed and check trees and by the first of September only a few scattered leaves remained upon the trees. By the first of October, these trees had entirely lost their foliage and were as bare as in mid-winter. Up to the first of October very few leaves had fallen from the trees of the liquid-sprayed plats. The foliage was practically intact and as green as in early summer. Most of the foliage was still on the trees when the work of the season was completed on October 23.

The whole line of plats was in full view from the much traveled highway on the west side of the orchard and the marked foliage differences attracted attention from all who passed. There was constant demand for explanation of the observed differences and information concerning the work, viewed as an illustration of direct

results from two methods of treatment as compared with no treatment, became widely disseminated.

Fruit.—Differences in foliage were not the only differences observable on the plats. From casual examination of the fruit upon the trees, it was at once evident that apple scab and fruit blotch had developed freely on the dust sprayed and check trees. Apples on these trees were, almost without exception, small, deformed, roughened and cracked by the advanced development of scab, and were totally worthless. They appeared in strong contrast with the larger, smooth, clean-skinned fruit from the liquid-sprayed trees.

The quantity of fruit borne by the trees was small, but considerably greater than in most orchards in the neighborhood. The crop was estimated at about one-fifth of a normal full crop. The trees produced abundant bloom, but the cold wet weather which prevailed through the blooming period, culminating in a hard "freeze" May 1, killed the greater portions of the young fruits. However, enough apples remained upon the trees to warrant continuing the experiment according to the plan. The number of apples recorded from all trees was 17,297. Of these, 13,162 or 76.09 percent were windfalls and 4,135 or 23.91 percent were picked from the trees. The distribution by numbers and percentages between the two sets of plats and the check rows was as follows:

	Windfalls.		Picked.		Total.
	Number.	Percent.	Number.	Percent.	
Liquid sprayed 4 plats—38 trees	6,223	68.04	2,923	31.96	9,146
Dust sprayed 4 plats—38 trees..	3,366	84.85	601	15.15	3,967
Check 7 rows—32 trees	3,573	85.39	611	14.61	4,184
					17,297

It will be noted that more than half or 52.88 percent of the total number of apples, came from the 38 trees sprayed with liquid, and that the rest were nearly equally divided between the dust-sprayed and the check trees; the former having nearly 23 percent of the total and the latter a little more than 24 percent. Further, it is seen that the percentage of windfalls is considerably higher for the dust-sprayed and check trees than it is for the liquid-sprayed trees. Had the same proportion of fruit remained on the dust-sprayed trees as was picked from the liquid-sprayed trees, we should have picked from the dust-sprayed trees 1,581, instead of 601 apples; more than two and a half times as many, or nearly 50 percent of the total number of apples borne by the 38 trees. In the same way, the check trees would have yielded 1,678 apples, instead of 611, or about forty-seven percent of the total number of apples from the check trees.

APPLE SCAB

The differences in amount of fruit gathered from the two sets of plats, as given above, were not due to any differences in size of the trees, or to differences in the amount of fruit originally on the trees, but may be directly charged to the development of apple scab. This fungus appeared early in the season, and with favorable conditions developed rapidly. On trees treated with liquid Bordeaux mixture, its development was almost entirely prevented, but on dust-sprayed and check trees, it continued to grow and spread. The apples were attacked when very small and a large proportion of them were so badly injured that they dropped from the trees in June and early July, decayed, and disappeared. Many apples that were injured in somewhat less degree remained longer on the trees, but before picking time, fell in such numbers as to increase greatly the percentage of windfalls. Apple scab appeared to grow as much without restraint upon the dust-sprayed trees as it did upon the check trees; no difference between the two could be detected.

For the fallen apples recorded, the percentage marked by scab was more than four times greater for the dust-sprayed than for the liquid-sprayed trees, and for the picked fruit the difference in favor of liquid-spray was still more marked. With all fruits, not only was the percentage affected greater for the dust-sprayed trees, but the degree of injury to individual fruits was very much greater. Liquid-sprayed fruits recorded as affected by scab, were, in great part, marked by small spots only, while fruits so recorded from the dust-sprayed and check trees, generally, had nearly the whole surface covered by the fungus. These fruits were small, deformed, cracked, and of no value.

All apples gathered, both picked and windfalls were separately examined and record made of the injury by diseases and insects. Record was also kept of those fruits attacked by bitter rot, but this has no bearing upon the relative merits of the two kinds of spray, because this disease appeared upon only a few trees scattered through the block. Bitter rot was confined to trees upon which it had appeared in previous seasons.

In the following tabulation are given the percentages of fruit affected by apple scab and these percentages are arranged by plats in order to show the results as influenced by the number of applications. The figures in the first two columns cover all fruits, both picked and windfallen; the other columns contain percentages derived from the picked fruit only.

PERCENTAGES OF FRUIT AFFECTED BY APPLE SCAB.

	All fruits.			Picked fruits only.		
	Liquid.	Dust.	Check.	Liquid.	Dust.	Check.
Plats 1 and 2						
Times sprayed 2.....	9.94	54.98		2.09	85.26	
Plats 3 and 4						
Times sprayed 4.....	8.53	40.61		1.14	84.62	
Plats 5 and 6						
Times sprayed 6.....	3.70	38.90		0.00	75.81	
Plats 7 and 8						
Times sprayed 7.....	3.39	49.03		0.00	91.73	
All plats	7.51	48.05	40.37	.89	85.69	82.49

The efficiency of Bordeaux mixture in liquid form as a preventive of apple scab is plainly shown by the percentages here given.

For the four liquid-sprayed plats only 7.51 percent of all the fruits, windfalls and picked, were marked by scab, as against 48.05 percent of the fruits from the four dust-sprayed plats. Considering picked fruits only, we have .89 percent for the liquid-sprayed plats as compared with 85.69 percent for the dust-sprayed plats. A further difference, not shown by the figures, is found in the fact that individual fruits from the liquid-sprayed trees were much less infected by the disease than were those from dust-sprayed trees.

The significance of an increased number of applications of liquid Bordeaux mixture is shown in the regularly decreasing percentages of infected fruits from Plat No. 1 to Plat No. 7 as the applications increased from 2 to 7. This is especially noticeable in the picked fruit column where for plats 5 and 7, with 6 and 7 applications, the scab was completely controlled. It is equally evident, from the percentages given, that dry Bordeaux was wholly ineffectual as a preventive of this disease.

Apple scab was the most prevalent disease, it was thoroughly established in the orchard and its early development did not yield readily and entirely, even to well-applied liquid Bordeaux mixture. To this disease is ascribed the loss of many small apples early in the season and it is almost entirely responsible for the early loss of foliage by all trees except those sprayed with liquid Bordeaux mixture.

FRUIT BLOTCH.

The fungus passing under the name of Fruit Blotch spreads in irregular, sooty black patches on the surface of the apple; it arrests development, causes cracking of the skin and is a conspicuous blemish. This fungus does not appear until mid-summer and does not

reach its period of most rapid development until the cooler weather of September. Distribution of the fungus in the orchard was not uniform; it was much more abundant on Plats 7 and 8 at the south end of the block than elsewhere and there were marked differences between trees of the same plat. Some were very badly infected, others were comparatively free. The fungus developed most abundantly and rapidly on fruits already marked by apple scab, but also attacked other fruits on which no scab appeared. The following tabulation gives percentages of all fruits infected and also the percentages derived from the picked fruit.

PERCENTAGES OF FRUIT AFFECTED BY FRUIT BLOTCH.

	All fruits.			Picked fruits only.		
	Liquid.	Dust.	Check.	Liquid.	Dust.	Check.
Plats 1 and 2						
Times sprayed 2.....	3.33	33.65		3.93	52.99	
Plats 3 and 4						
Times sprayed 4.....	7.28	48.66		9.78	57.34	
Plats 5 and 6						
Times sprayed 6.	5.93	55.62		6.56	51.61	
Plats 7 and 8						
Times sprayed 7.....	16.46	47.08		14.32	29.66	
All plats.....	7.50	43.23	34.35	9.07	48.25	44.03

The percentages here given are decidedly in favor of liquid Bordeaux, although they do not indicate so perfect control as was obtained over apple scab. This is probably due to the fact that spraying was done early during the period when apple scab naturally develops, while with the fruit blotch much of the infection came long after the last spraying was done. The percentage of fruit attacked on Plat No. 7 was very high in comparison with other plats, notwithstanding the increased number of applications. This was due to the greater abundance of the fungus on that plat and to very late infection on many fruits. This late infection was, on most fruits, very slight; enough to indicate the presence of the fungus, but not causing serious blemishes.

The dust spray proved no more effective in controlling fruit blotch than in preventing apple scab.

CODLING MOTH

Neither liquid nor dust spray proved very effective this season against this insect. Considering all fruits, the gain of liquid Bordeaux over the check trees was 6.35 percent and the gain of liquid over dust was 7.79 percent or, calculating from picked fruit only, the liquid shows a gain over check of 23.84 percent and a gain over

dust of 22.91 percent. The small percentages of benefit here shown are ascribed to weather conditions. Heavy rains, which were of frequent occurrence during the spraying period washed away the Paris green, leaving no protection against this insect.

CURCULIO

The percentages of fruits marked by curculio show but trifling benefits from either form of spray. For all apples of all plats, 13.68 percent of liquid-sprayed fruits were marked by curculio, 16.76 percent of dust-sprayed fruits and 14.65 percent of fruits from check trees. For the picked fruit a slightly greater gain is shown, but too small to be regarded as a commendation of spraying. It was shown in Bulletin No. 98 that the curculio feeds anywhere on the fruit and that perfect protection would mean the complete covering of the surface with poison. This can not be done in a practical way and, while it was shown that under favorable circumstances from 20 percent to 40 percent of benefit might be obtained by spraying, the benefit is so commonly far below this that spraying is not highly commended as a remedy for curculio.

SUMMARY OF THE WORK IN 1903

Summarized results for the season of 1903 were decisive; the differences between liquid and dust-sprayed plats were so marked as to leave no doubt in the minds of the most casual observers.

Liquid Bordeaux proved its efficiency in controlling the dominant fungi, while dust spray was entirely ineffective; so much so that no differences were apparent between dust-sprayed and check trees in retention of foliage or in character of fruit.

Results in preventing insect injury were not markedly successful, owing, in part, at least, to unfavorable weather conditions, but such benefit as was attained was on the side of liquid applications.

EXPERIMENTS IN 1904

To add the experience of another season, to augment the data already gathered regarding the relative merits of the two methods of applying spray materials and to verify the results of 1903, the work was repeated in the W. C. Reed orchard and duplicated in the orchard of Mr. John Sawdon near Griggsville in Pike county.

THE REED ORCHARD IN 1904

In the Reed orchard the same trees were used and the schedule of applications was the same as that used in 1903. Spring weather was favorable, no omissions were necessary and the applications for

the season of 1904 were 3, 5, 7, and 8, instead of 2, 4, 6, and 7. A new "Cyclone" dust machine was purchased and used; prepared dry Bordeaux and Paris green was obtained fresh from the factory and all applications were made in the most thorough manner. The quantity of apples borne by the trees was over six times as great as in 1903, a practically full crop, and in general the conditions were favorable for a fair test of the two methods of spraying.

Foliage.—In the Reed orchard the foliage fell or remained upon the trees, according to the treatment given, just as it did in 1903.

Differences between the liquid-sprayed trees and the others were apparent in July and as the season advanced the differences became more marked. By the middle of September the dust-sprayed trees and the check trees were almost entirely denuded, while, on the liquid-sprayed trees, the dark green, healthy leaves continued to perform their functions until the close of the season. The cause of the loss of foliage by the dust-sprayed and check trees was, as in 1903, the unrestricted development of apple scab.

The accompanying illustrations, plates 1, 2, and 3 serve to show in some degree the foliage differences between liquid-sprayed, dust-sprayed and check trees as they appeared on October 27, 1904.

Plate 4 shows the defoliated condition of a portion of the orchard east of the plats. No applications of any kind had been made to these trees.

Fruit.—Early in July differences in the appearances of the fruit on the different plats became apparent. Fruit on liquid-sprayed trees was smooth and comparatively free from the blemishes which were conspicuous on fruit of dust-sprayed and check trees. These differences increased as the season advanced; they attracted the immediate attention of all who visited the orchard.

The following tabulation gives the total number of apples from each set of plats and the relation by numbers and percentages of windfallen and picked apples.

RELATION OF WINDFALLEN AND PICKED APPLES BY NUMBERS
AND PERCENTAGES.

	Windfallen.		Picked.		Total.
	Number.	Percent.	Number.	Percent.	
Liquid sprayed, 4 plats, 38 trees	14,677	32.21	30,896	67.79	45,573
Dust sprayed, 4 plats, 38 trees	15,205	42.62	20,474	57.38	35,679
Check, not sprayed, 7 rows, 32 trees	14,585	47.30	16,248	52.70	30,833
Totals	44,467	39.64	67,618	60.33	112,085

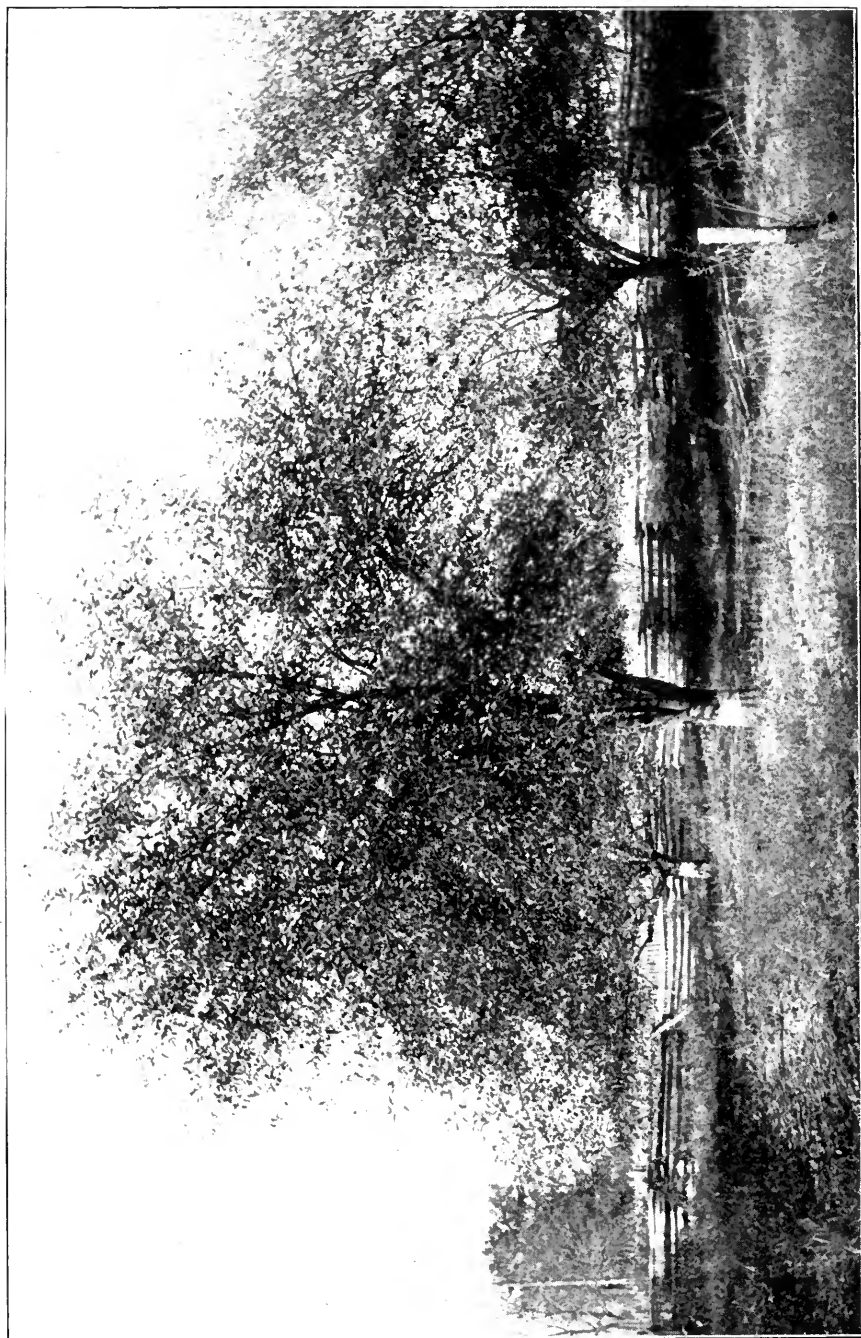


PLATE 1.—REED ORCHARD, OLNEY. OCTOBER 27, 1904. TREE NO. 6 OF PLAT NO. 1. LIQUID SPRAYED.

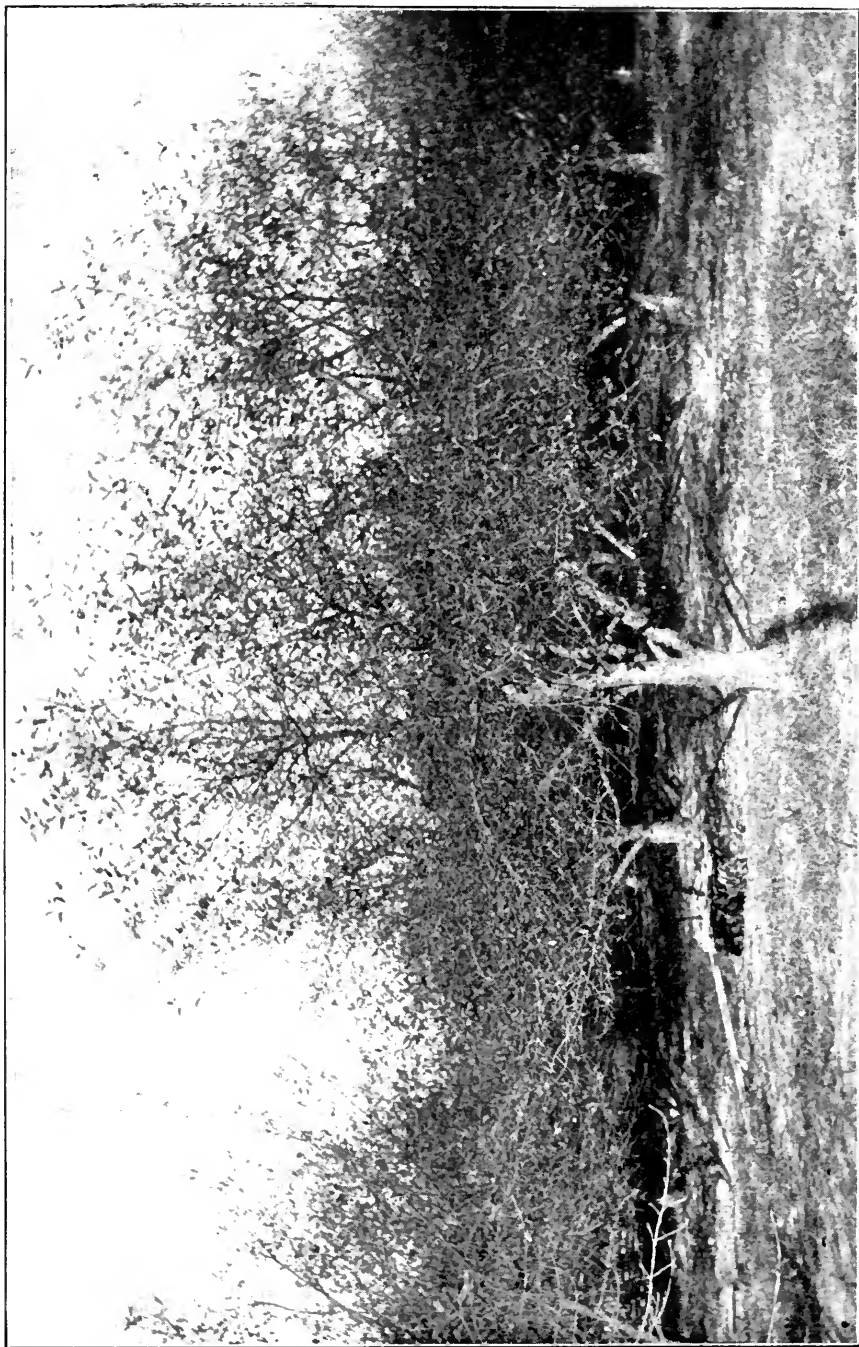


PLATE 2.—REED ORCHARD, OLNEY. OCTOBER 27, 1904. CENTRAL FOREGROUND. TREE NO. 4 OF PLAT NO. 2. DUST-SPRAYED.

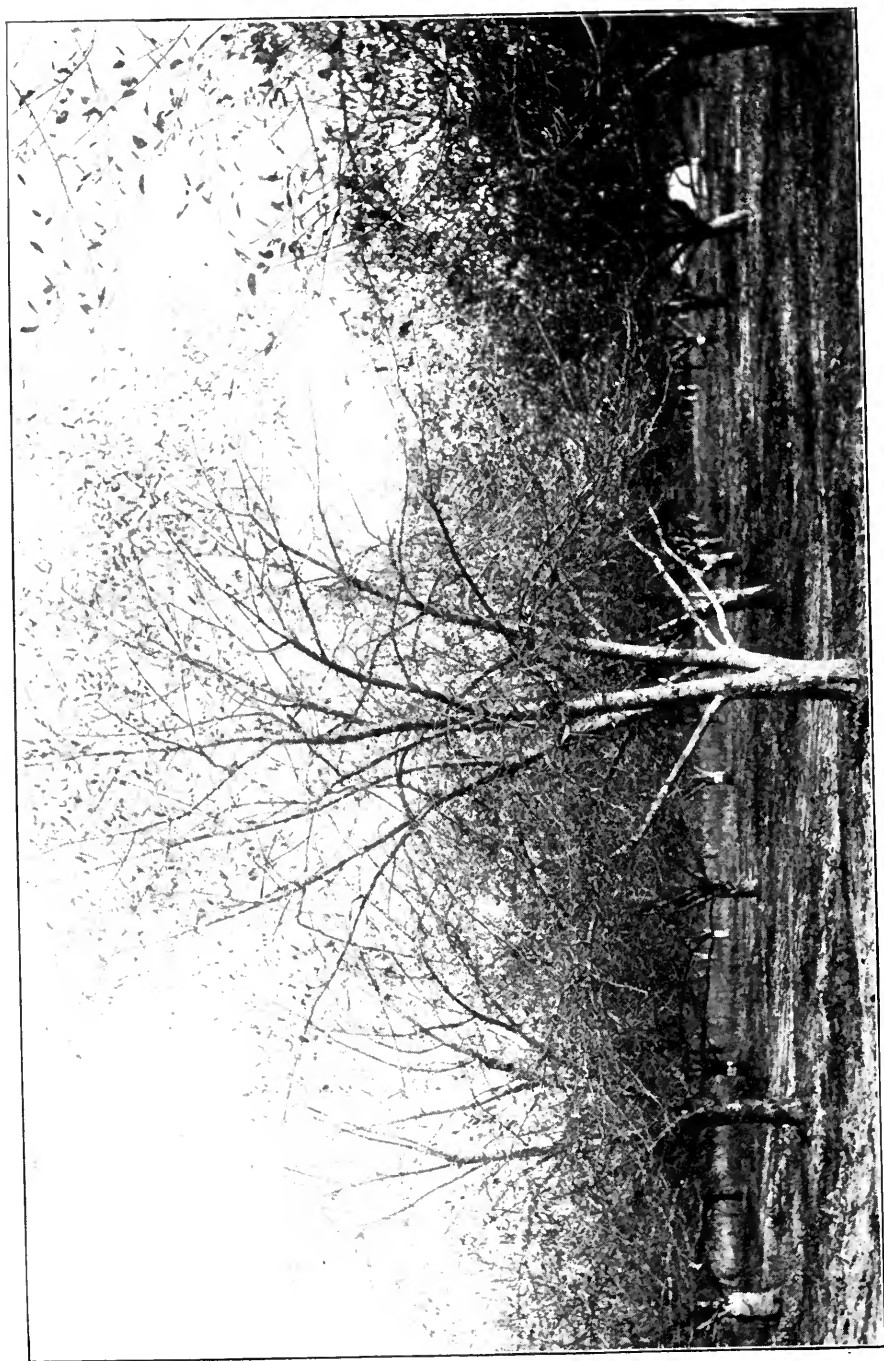


PLATE 3.—REED ORCHARD, OLNEY. OCTOBER 27, 1904. CENTRAL FOREGROUND. TREE NO. 4 OF CHECK ROW NO. 2. NO SPRAY.

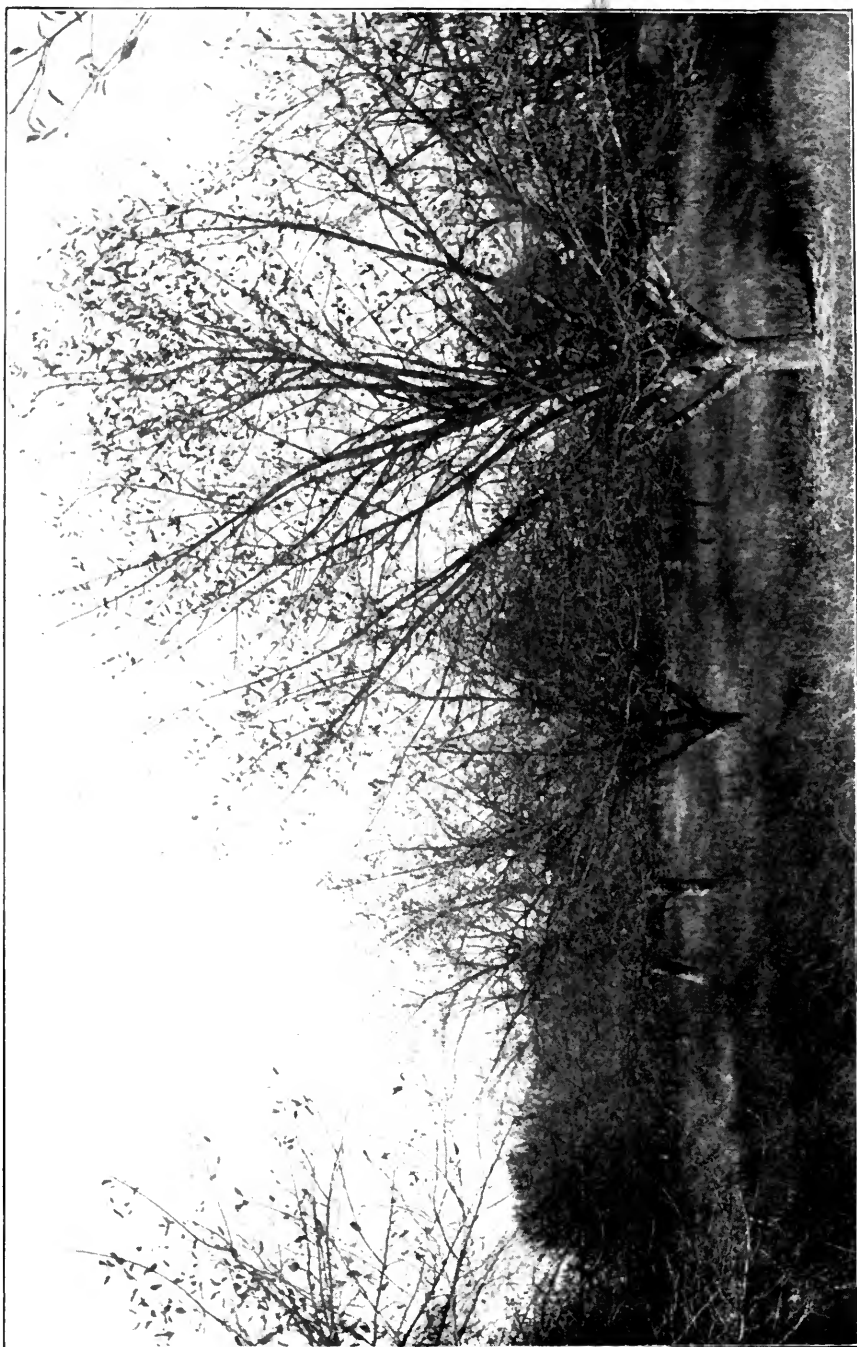


PLATE 4.—REED ORCHARD, OLNEY. OCTOBER 27, 1904. LOOKING NORTHEAST ALONG AN UNTREATED ROW.
THE THIRD ROW EAST OF PLATS. FOLIAGE PRACTICALLY ALL GONE.

Comparing the percentages here given with those of 1903 a marked difference is apparent. While in 1903 only 31.96 percent of the total number of apples produced by the liquid-sprayed trees remained upon the trees until picking time, in 1904 the same trees held 67.79 percent. There is the same difference regarding other plats. The dust plat figures are 15.15 percent for 1903 and 57.38 percent for 1904. For the check trees 14.61 percent for 1903 and 52.70 percent for 1904. The greatly increased amount of fruit and the better weather conditions of spring are accountable for these differences.

APPLE SCAB

Apple scab was as abundant as in 1903. The number of apples was nearly six and one half times as many as in 1903 and the percentage affected by the disease was considerably higher than last year. This is due largely to a development of the disease late in the fall and so long after the last spray was applied to plats 1, 2, 3, and 4 that the Bordeaux had been almost completely washed from the fruit. However, this late infection did not result in serious blemishes on liquid-sprayed fruit, merely small, and mostly very small, discolored spots on the surface, not sufficiently developed to roughen the epidermis.

The percentages for all fruits affected were as follows:

PERCENTAGES OF FRUIT MARKED BY APPLE SCAB.

	Liquid sprayed, percent of scabby fruit.	Dust sprayed, percent of scabby fruit.
Plats 1 and 2		
Times sprayed 3.....	63.03	88.27
Plats 3 and 4		
Times sprayed 5.....	28.56	82.14
Plats 5 and 6		
Times sprayed 7.....	18.20	63.62
Plats 7 and 8		
Times sprayed 8	8.47	73.40
Check, no spray.....		83.17%

This tabulation includes all apples marked in the slightest way by apple scab, but it conveys no adequate idea of the difference in appearance between the fruit from the liquid-sprayed and that from the other trees. The liquid-sprayed fruit generally appeared clean and smooth as seen, either on the trees or on the sorting tables. Fruit from the dust-sprayed and check trees was smaller and much discolored and disfigured by the large spots of scab. In recording the fruit blemishes, a division was made between those apples marked only by few and small spots of scab and those having many



FIGURE 1.—FRUIT FROM TREE NO. 8 OF PLAT NO. 5. SPRAYED WITH LIQUID.



FIGURE 2.—FRUIT FROM TREE NO. 1 OF PLAT NO. 6. SPRAYED WITH DUST.



FIGURE 3.—FRUIT FROM TREE NO. 1 OF CHECK ROW NO. 2. NOT SPRAYED.

and large spots; this division places over 90 percent of the liquid-sprayed apples in the slightly marked class, leaving less than 10 percent recorded as much marked. Dust-sprayed fruit was nearly equally divided between the two groups, and with the fruit from the check trees a little more than half were in the badly scabbed class.

By comparing plat No. 1 which had 63 percent of the fruit marked by scab with plat No. 7 which showed only 8.47 percent of infected fruit it is plainly shown that the later applications of Bordeaux mixture prevented late infection.

The accompanying figures are fair photographic representations of the manner in which fruit from the different sets of plats graded.

Figure 1 shows the picked fruit from tree No. 8 of plat No. 5 sprayed seven times with liquid Bordeaux and Paris green.

The total number of apples was 1009, divided as follows:

3¼ bushels No. 1.....	440 apples
3 bushels No. 2.....	488 "
½ bushel culls.....	81 "

Figure 2 shows the fruit from tree No. 1 of plat No. 6 sprayed seven times with Bordeaux and Paris green, as dust.

The total number of apples was 1,102 divided as follows:

5 only No. 1.....	5 apples
4½ bushels No. 2.....	682 "
1½ bushels culls.....	415 "

Figure 3 shows the fruit from tree No. 1 of check row No. 2, not sprayed.

The total number of apples was 1049 divided as follows:

0 No. 1.....	0 apples
1½ bushels No. 2.....	308 "
2½ bushels culls.....	741 "

FRUIT BLOTCH

The percentages of fruit blotch on fruit from liquid-sprayed trees ranged from 3.59 percent on plat No. 7 which was sprayed eight times, to 16.54 percent on plat No 1 which was sprayed three times. Percentages on dust-sprayed trees ranged from 51.67 percent to 74.18 percent and the check trees showed 51.39 percent of infected fruit.

The fungus yielded quite readily to applications of liquid Bordeaux, but dust applications were entirely inefficient in controlling it.

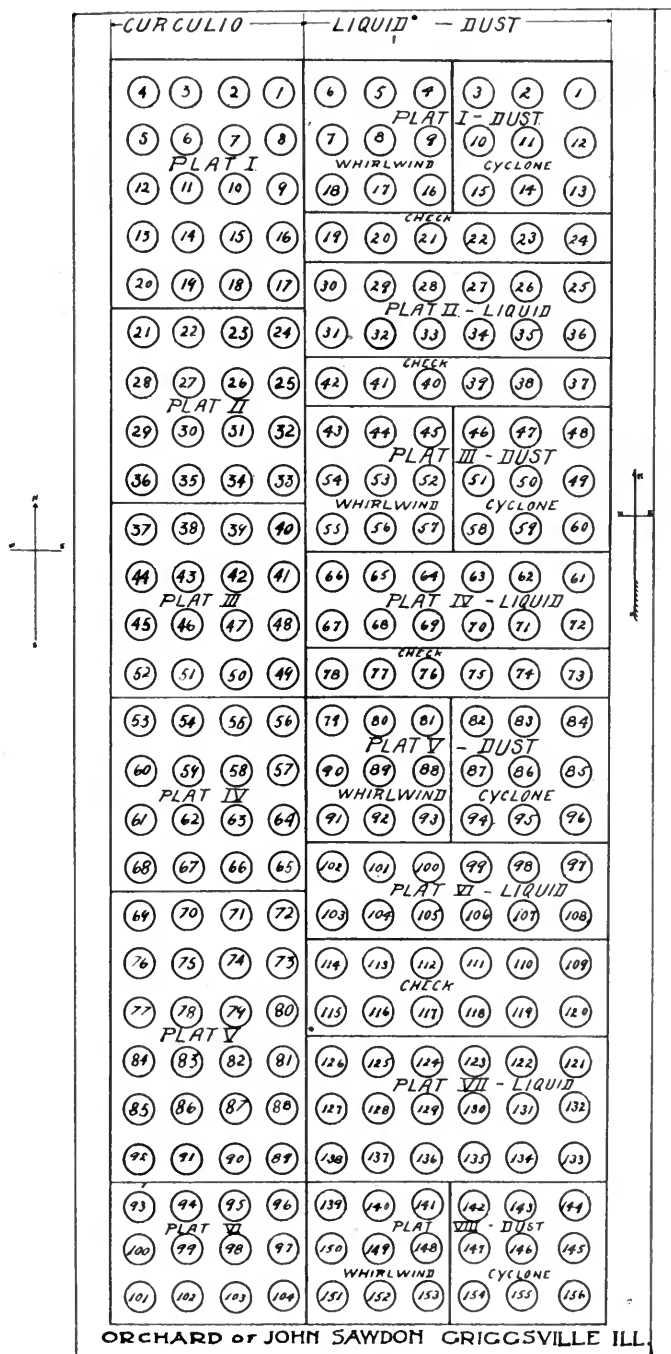


FIGURE 4.

EXPERIMENTS NEAR GRIGGSVILLE

At Griggsville the work was conducted in connection with experiments for control of curculio which were then in progress. Six rows containing 136 trees were included in the experiment. Four plats aggregating 67 trees were sprayed with dust and four containing 47 trees were sprayed with liquid. Five rows across the block, located between plats and containing 22 trees were not sprayed and served as control trees for comparison with the treated plats.

The four plats to be treated with dust were purposely made somewhat larger than the others in order to admit of division for testing two machines and the prepared dust as made by two companies. One half of each dust plat was scheduled for spraying with the "Cyclone" machine and the prepared Bordeaux as made by the "Dust Sprayer Manufacturing Company" of Kansas City, Missouri; the other half with the "Whirlwind" machine and the "Dry Bordeaux" as manufactured by the "Kiser Whirlwind Duster Manufacturing Company" of Stanberry, Missouri.

After thorough trial the "Whirlwind" machine was abandoned as wholly inefficient. The division of plats was maintained, but the two kinds of dust were applied with the one machine, the "Cyclone," which did the work in a satisfactory manner. At the close of the season there was no appreciable difference between the divisions of these plats; each plat is tabulated as a whole and nothing further need be said of this division. The accompanying diagram, Figure 4, shows the location and arrangement of the plats.

Foliage—Differences in foliage between liquid-sprayed trees on the one hand, and dust-sprayed and check trees on the other, the same differences that were observed in the Reed orchard, were apparent in the Sawdon orchard, but not to quite the same extent. Liquid-sprayed trees held the foliage as perfectly, but dust-sprayed and check trees did not lose the leaves quite as rapidly and completely as did the corresponding trees in the Reed orchard. This is ascribed, in part, to a less vigorous attack of apple scab and, in part, to differences in varieties. In the Reed orchard the trees are all Ben Davis, in the Sawdon orchard the varieties are Milam and Wealthy. The Milam trees held the foliage rather better than did the Ben Davis, and the Wealthy held the foliage better than either of the others.

Fruit—Of the trees included in the block, the Wealthy bore a very heavy crop, the Milam a fair crop. The total number of apples recorded was 132,707 and the distribution between liquid plats, dust plats and check rows is shown by numbers and percentages for both picked and windfallen fruits in the following table.

NUMBERS AND PERCENTAGES OF WINDFALLEN AND PICKED APPLES.

	Windfallen.		Picked.		Total.
	Number.	Percent.	Number.	Percent.	
Liquid sprayed 4 plats	23,568	48.64	24,893	51.36	48,461
Dust sprayed 4 plats	43,509	63.09	25,450	36.91	68,959
Check 5 rows.	10,435	68.26	4,852	31.74	15,287
Totals.	77,512	58.41	55,195	41.59	132,707

The fact that the percentages of fruit harvested from the trees are not as high as for the Reed orchard is explained by the operation of additional agencies that largely increased the number of dropped apples in the Sawdon orchard. Apple scab was about equally abundant in the two orchards. Curculio was very much more abundant in the Sawdon orchard and is responsible for the fall of many apples. To the work of this insect may be added the action of high winds, early in October, which brought to the ground a considerable portion of the Milam apples. However, spraying helped to retain the fruit upon the trees as is shown by comparison of the percentages given, although full benefit of the applications is in a measure obscured by the necessity of including with the windfalls the apples brought down by wind and those falling from attacks of curculio, an insect for which spraying is not an effective remedy. Comparing the percentages of picked fruit, it is found that the dust-sprayed plats show a gain over the check trees of 14 percent and the liquid-sprayed a gain of 38.20 percent. Apple scab attacked a proportionately greater number of apples in the Sawdon orchard than in the Reed orchard, but the injury to individual fruits was usually less.

In general appearance the apples from the Sawdon orchard were better than those from the Reed orchard, mainly because of the entire absence of fruit blotch. This fungus on account of its dark color and its action in cracking the fruit does more to render apples unsightly than any other fungus, and when it makes an attack jointly with apple scab the destructive action is complete.

The percentages of fruit marked by scab in the Sawdon orchard range from 56 to 68 percent for the liquid-sprayed plats; 86 percent to 96 percent for the dust-sprayed plats and 96 percent for the check trees. These percentages are higher than for the fruit in the Reed orchard and do not indicate so much benefit from increased number of applications of liquid Bordeaux.

Separating the fruit marked by scab into two groups, one very slightly marked, the other showing large spots, 82 percent of the

liquid-sprayed fruits, 43 percent of the dust-sprayed fruits and 31 percent of the fruit from check trees fall into the slightly marked group. This leaves 18 percent of liquid-sprayed fruits in the much marked group, which, considering the fact that the orchard had not been sprayed in previous years, is a fairly low percentage.

As in the Reed orchard, it required the record from individual fruits to bring out any difference between fruit from the dust-sprayed trees and the check trees. Observation of the fruit on the trees and on the tables did not discover that there was any difference. Liquid-sprayed fruits, however, were very different in appearance from those on dust-sprayed and check trees. They were larger, smoother, and in every way more desirable.

CODLING MOTH

This insect was moderately abundant and the sprays applied were fairly successful in controlling it. The fruit from check trees showed 17.29 percent infested; from dust-sprayed trees 10.45 percent, and from liquid-sprayed trees 6.53 percent. Computing the gain of sprayed trees over the unsprayed trees, the dust-sprayed fruit shows gain over the check of 39.56 percent. Liquid-sprayed fruit shows gain over the check of 62.23 percent. In the same way the gain of liquid spray over the dust spray is 37.51 percent.

CURCULIO

The abundance of curculio and the relative efficiency of the two methods of spraying is shown in the following percentages. Of fruits from check trees 93.76 percent were punctured by curculio. The percentage for the dust-sprayed trees was 81.09, and for the liquid-sprayed 55.53, or a gain of dust-sprayed over check trees of 13.51 percent, of liquid-sprayed trees over check trees of 40.77 percent and of liquid-sprayed trees over dust-sprayed trees of 31.52 percent.

During the progress of the experiments at Griggsville and Olney, many orchard owners, and others interested, visited the orchards and inspected the work. The differences between plats were so marked and the results of the different applications so evident to the eye that all visitors obtained distinct impressions of the relative merits of the two methods of treatment and were particularly impressed with the practical benefits to be derived from the right application of Bordeaux mixture in liquid form.

October 10, just before the final picking of Milam apples began, a party of twelve, consisting of the Advisory Committee and others

from different parts of the state met in the Sawdon orchard for inspection of the work. On this occasion the suggestion was made and acted upon, that a committee of disinterested persons be appointed to select average samples of the fruit from different plats. This committee performed the assigned duty and after the samples had been examined, they were photographed, sent to cold storage and exhibited at the meeting of the State Horticultural Society at Bloomington in December. Accompanying the samples was the following explanatory note:

ORCHARD OF JOHN SAWDON

GRIGGSVILLE, ILLINOIS, October 10, 1904.

This is to certify that we, the undersigned, have this day selected characteristic average specimen apples from each of the several plats respectively sprayed with—

Bordeaux and Paris green dust.

Liquid Bordeaux and Paris green mixture.

Checks—no spray whatever.

These collections are duly labeled and correctly represent the apples as borne on these trees. We were selected on the ground as a committee for this purpose by Dr. T. J. Burrill of the University of Illinois. The experiments were conducted under the direction of the Department of Horticulture of the Agricultural Experiment Station.

(Signed) W. S. PERRINE,
H. A. ALDRICH,
F. D. VORIS,
A. V. SCHERMERHORN,
C. G. WINN,
Committee.

The three samples of apples were critically examined and blemishes recorded as shown below.

Treatment.	Number of apples.	Curculio.	Codling moth.	Other insect injury.	Apple scab.	Perfect apples.
Liquid spray.	50	14	0	1	35	8
Dust spray.	132	103	1	3	131	0
Check, no spray.	111	108	6	24	111	0

The apples were collected in large paper sacks and the sacks were about equally full. The differences in number of fruits are due to differences in size of individual fruits.

Stating the blemishes in percentages, curculio had attacked 28 percent of the liquid-sprayed apples, 78.03 percent of the dust-sprayed apples, and 97.30 percent of the apples from the check trees.

For codling moth the percentages are 0.76 for dust-sprayed fruits, 5.40 for check tree fruits, with no work of this insect on the liquid-sprayed fruits. Various other insects had left marks on 2 percent

of the liquid-sprayed fruits, on 2.27 percent of the dust-sprayed apples and on 21.62 of the apples from the check trees. Apple scab was present on 70 percent of the liquid-sprayed apples, on 99.24 percent of the dust-sprayed apples and on 100 percent of the fruit from check trees.

These sample apples as photographed are shown in Figure 5.

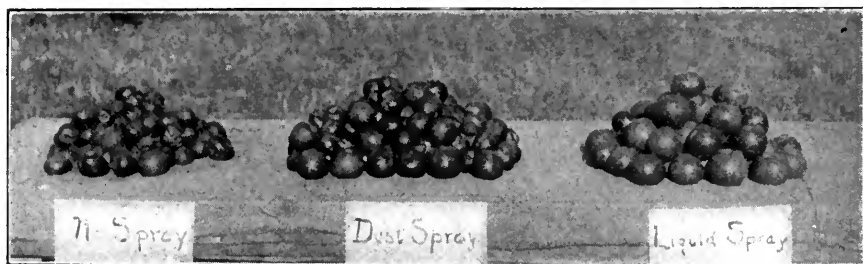


FIG. 5. REPRESENTATIVE APPLES FROM CHECK TREES, DUST SPRAYED, AND LIQUID SPRAYED PLATS. SAWDON ORCHARD, GRIGGSVILLE, 1904.

ADDITIONAL EXPERIMENTS IN 1905

The results obtained in the experiments of the two seasons 1903 and 1904 give a perfectly plain answer to the question of the relative efficiency of dust spray as compared with liquid spray, but to make still further additions to the data already gathered and to furnish a practical demonstration in a section of the state where orcharding is a principal business, a somewhat less extensive experiment was conducted during the summer of 1905 in connection with certain bitter rot experiments in an orchard at Clay City.

Six plats of twelve trees each were used in the work. Two plats were sprayed with liquid Bordeaux and Paris green, one six times, the other nine times; two plats were sprayed with prepared dry Bordeaux and Paris green applied as dust, one six times, the other nine times, and two plats were reserved as control and were not sprayed.

Foliage of the trees included in this experiment behaved exactly as did the foliage in the Reed orchard in 1903, and again in 1904. Leaves began falling from dust-sprayed and check trees in July, and by the first of September these trees were entirely defoliated, while the 24 trees sprayed with liquid Bordeaux retained the foliage perfectly. The cause of the loss of foliage from dust-sprayed and check trees was, as in previous seasons, the unchecked development of apple scab.

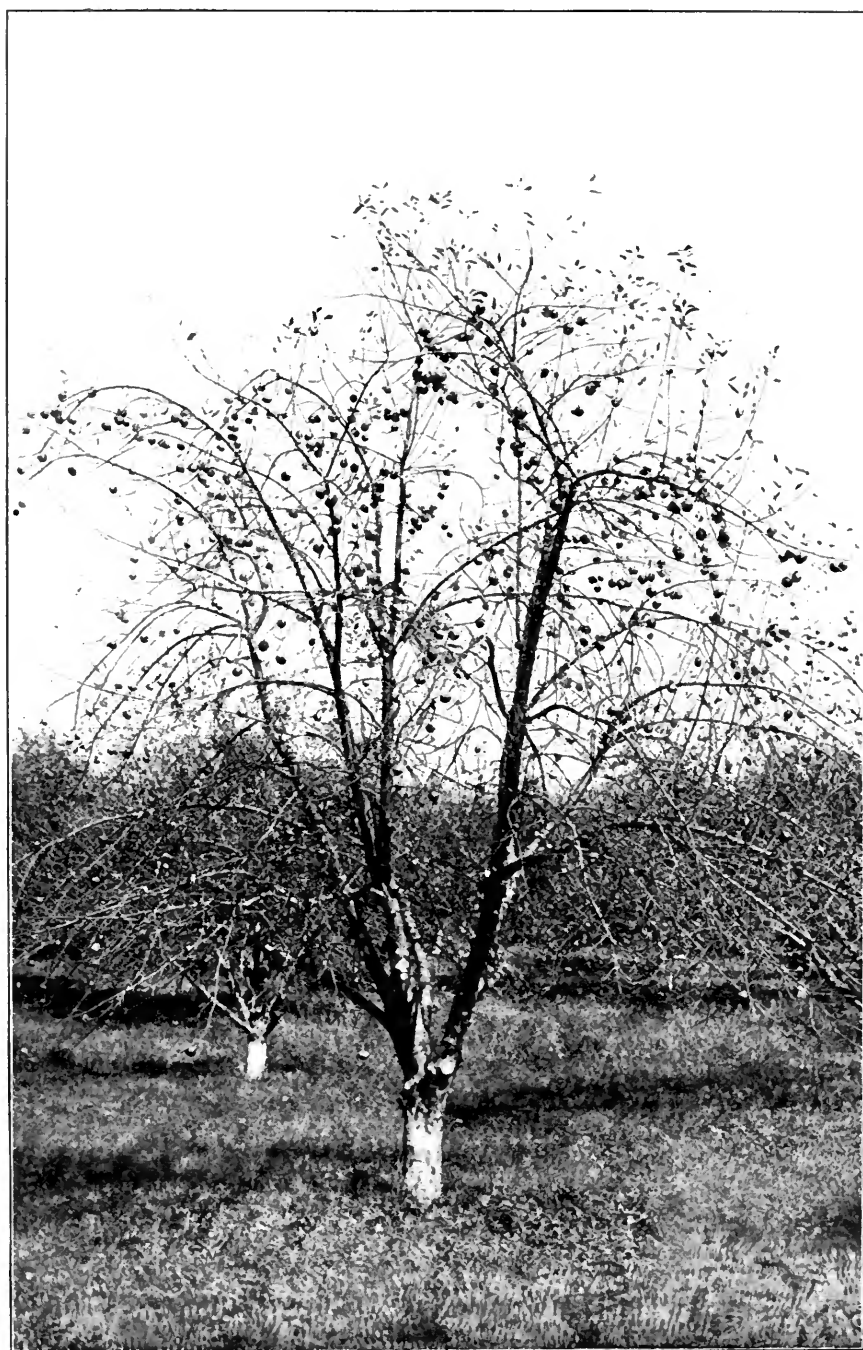


PLATE 5.—TREE NO. 10 OF PLAT NO. 11. CLAY CITY ORCHARD. CHECK,
NO SPRAY. FROM PHOTOGRAPH SEPTEMBER 26, 1905.

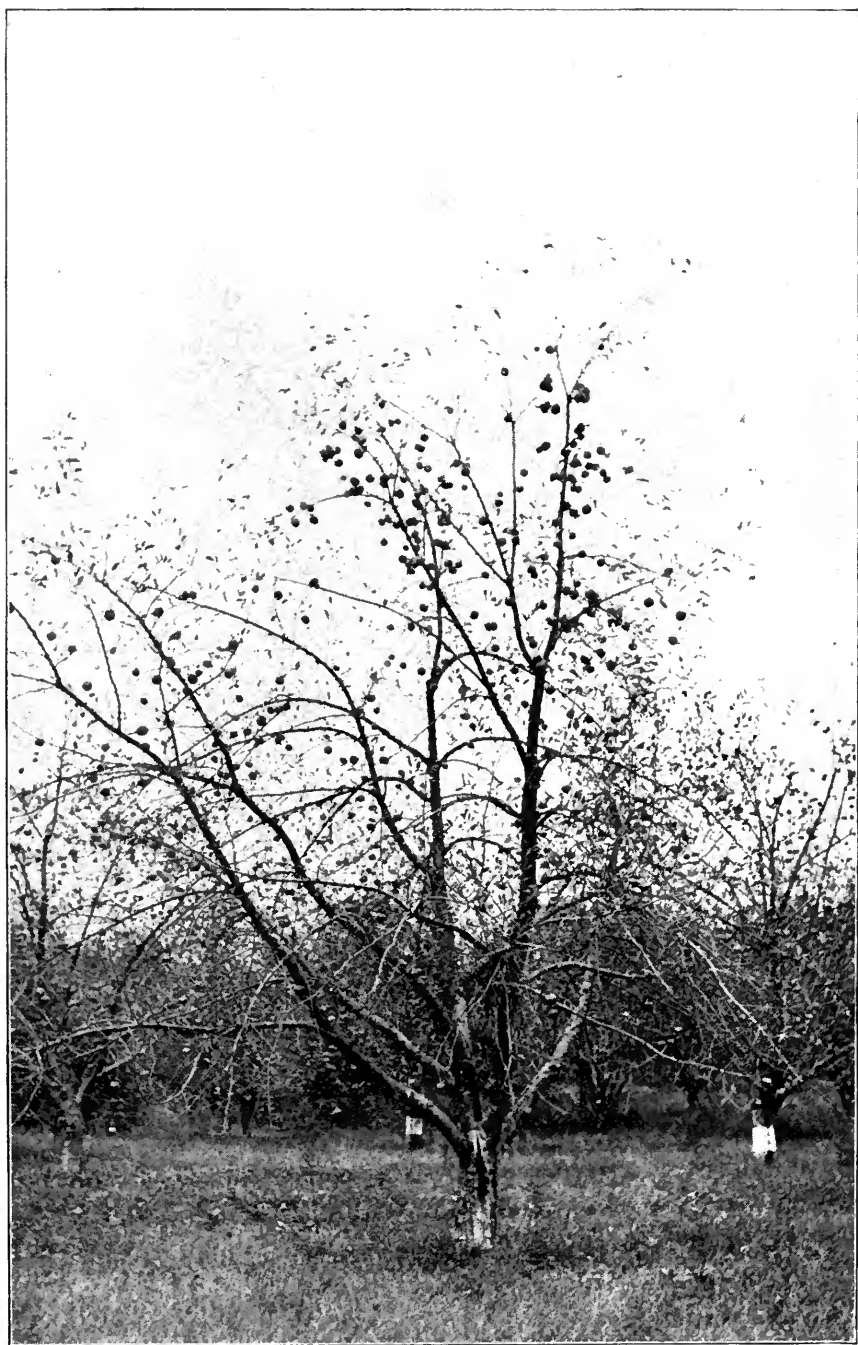


PLATE 6.—TREE NO. 7 OF PLAT NO. 13. CLAY CITY ORCHARD. SPRAYED WITH DUST. FROM PHOTOGRAPH SEPTEMBER 26, 1905.

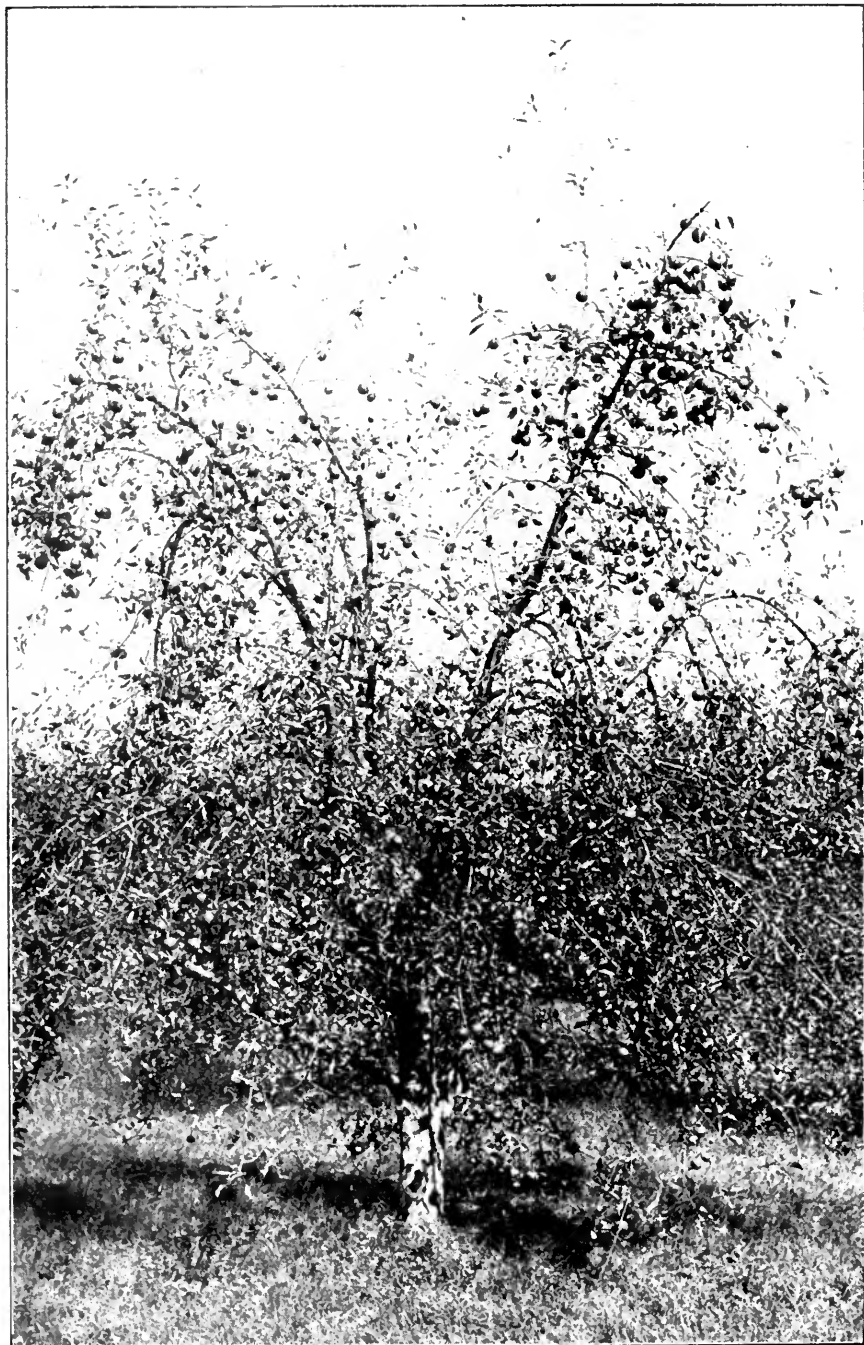


PLATE 7.—TREE NO. 8 OF PLAT NO. 12. CLAY CITY ORCHARD. SPRAYED WITH LIQUID. FROM PHOTOGRAPH SEPTEMBER 26, 1905.

The striking contrast between defoliated plats and green-leaved plats was at once observed and commented upon by those who visited the orchard. Many sought information regarding treatment given, and made detailed examinations of the plats from which conclusions were drawn regarding the relative merits of the methods used.

The relative condition of foliage on the different plats is shown by plates 5, 6, and 7 which are from photographs taken on September 26.

A total of 110,637 apples were produced by the 72 trees. The two check plats are credited with 30,717; the two liquid-sprayed plats with 46,842; and the two dust-sprayed plats with 33,078. Regarding the division between windfallen and picked apples, 50.68 percent of the total number of apples produced by the check trees were picked from the trees. For the liquid-sprayed trees the percentage of picked fruit was 79.10, and for the dust-sprayed trees 55.16. The computed gain in picked fruit over the check trees is, for the dust-sprayed trees 8.12 percent and for the liquid-sprayed trees 35.92 percent.

No differences could be detected between the fruit of dust-sprayed trees and that from check trees in the amount of infection from apple scab; both lots were so badly infected that they were of no value except as evaporator stock. On the other hand, the fruit from the liquid-sprayed trees was very little marked by scab and the percentage of good barreling stock was high.

The results of this last experiment were as decisive as any obtained. They were so plain that the most casual observer could read them at a glance and understand their meaning. As an actual demonstration of the relative merits of dust and liquid spray the experiment served a most excellent purpose. It did more, it helped to impress orchard owners with the absolute necessity of combating insects and fungi and pointed out the successful way.

RELATIVE COST

Throughout the experiments records were kept of the amount of labor and materials used. From these records the cost of one application to one tree is computed to be 3.62 cents for the liquid spray and 2.38 cents for the dust spray. The dust spray, therefore, costs 1.24 or 52 percent less per tree than the liquid spray. In other words, six applications of dust can be made for a trifle less than the outlay required for four applications of liquid. If cost were the only consideration, liquid spray would be quickly discarded in favor of the dust spray, but in considering the value of two methods

of treatment, relative efficiency must take precedence over relative cost. The labor and material for any application is thrown away unless a profit is returned by the result secured. Any material applied that will not control fungous diseases and check insect ravages fails of its purpose and is costly at any price.

TRANSPORTATION

Great advantage is claimed for dust spray because the weight to be hauled about the orchard is so much less than when liquid spray is used. It is true that the dust required for a given area is many times lighter than the liquid required for the same area and is much easier to transport, but this contention like cost, must be entirely subordinate to the efficiency of the application.

THOROUGHNESS OF APPLICATION

Advocates of dust spray claim greater certainty of thorough work, that is, of completely covering the trees. They say "the dust is carried in a cloud and must settle over the most remote limbs as well as on those near at hand." There is little force in this argument because there is the same possibility of carelessness on the part of workmen in applying dust that there is in applying liquid.

A good dust machine will throw a cloud of dust, if worked with sufficient force and, if there is no wind and if the delivery tube be rightly directed it may and will be distributed over the trees. In like manner, a good spray pump if worked with sufficient force will, if the nozzle be properly manipulated, distribute liquid spray to all parts of trees. Wind is as much against even distribution of dust as it is against even distribution of liquid.

With elevated platform and extension rods, as now commonly used in applying liquid spray, it is entirely possible to reach all parts of orchard trees, but, with either method of spraying, whether distribution is even or not depends upon the men who supply the force and who direct the delivery.

PERSONAL COMFORT OF WORKMEN

Spraying, at best, is not a pleasant operation. The irritant nature of the lime dust is especially annoying to workmen, for, no matter how careful, they at times become enveloped in a cloud of it and take more or less of it into the lungs. Liquid spray is often blown into the faces of the workmen and its corrosive action upon the skin is not pleasant. But the workmen who assisted in the station experiments were unanimous in choosing liquid spraying as the least disagreeable of the two.

CONCLUSION

Insects and fungi injurious to fruit crops are assumed to be here as a permanent fixture and, in order to secure marketable fruit, it is absolutely necessary to combat the pests in some manner. Thousands of dollars have been spent experimentally in the effort to determine which of all the remedies suggested could be relied upon to produce the best results at least cost.

The results of experiments led to the introduction of Bordeaux mixture, applied as a liquid spray, as a remedy for fungi and various forms of arsenic as remedies for chewing insects.

These remedies have come into general use and, while frequently failing to give perfect satisfaction, because of improper preparation, careless application, or too frequent downpours of rain, are still recognized as the best that have been discovered up to the present time.

The introduction of dry Bordeaux mixture applied with arsenites as a dust spray was prompted by a desire to decrease the cost and labor of spraying. It does both of these things, but its value can not rest upon cost and ease of application. The final test of value is, and must be, *efficiency* in preventing injury from fungi and in killing insects.

The experiments conducted by the department of horticulture, testing the relative efficiency of the wet and dry sprays have extended over three seasons; they have included an aggregate of 424 trees, 147 of which were sprayed with liquid, 167 with dust, and 110 maintained as control trees which received no spray. The number of apples produced by these trees totals 372,726. These fruits were examined individually and record made of blemishes.

The experiments have been reasonably extensive, they have been carefully executed and the conclusions drawn are fully warranted by the results obtained.

With regard to the effects upon foliage the results were identical in all orchards and in all seasons. Trees sprayed with liquid Bordeaux and Paris green retained their foliage in healthy working condition throughout the season. Dust-sprayed and check trees may be placed together because the behavior of foliage was the same in both. Leaves began falling in July and, in early September, these trees were practically denuded. This loss of foliage by dust-sprayed and check trees was due to apple scab, against which disease the dust spray was entirely ineffective. The effects of this loss of foliage are very serious. The assimilatory processes of trees are active in proportion to the working leaf surface; as leaves fall,

these processes diminish until brought to a stop by the entire loss of foliage, long before the work of the season should normally end. The fruit is starved, does not approach normal size, and buds for the next year can not be properly developed.

It also frequently happens that under the stimulus of rains and high temperatures in October, leaf buds of the defoliated trees, that normally should remain dormant until spring, unfold and expand clusters of new leaves. This renewed and abnormal activity of the trees affects fruit buds also; a considerable portion of them have been observed to swell and some expand the flowers. All this is greatly to the detriment of the trees and fatal to the prospective crop for the next year. It emphasizes the necessity of such treatment as will retain the foliage in full working condition until the end of the season.

Compare the tree shown in plate 8, which was sprayed six times with liquid Bordeaux and Paris green with the tree in plate 9, which was not sprayed. The difference is striking. In one case the foliage of the season is intact and doing full work, in the other, not only has the foliage of the season been lost, but in the attempt to repair the loss, buds that should have remained dormant until the next spring have been called into activity and have put forth leaves.

This extra draft upon the resources of the tree impairs vitality. The tree enters the winter in weakened condition and, while it may survive, is unprepared to bear a crop or even to make satisfactory growth the next season.

Differences in fruit were as marked as were differences in foliage. Liquid-sprayed trees gave smooth fruit of good size. Dust-sprayed and check trees gave small, ill-formed fruit, badly marked by scab and of very little value even as evaporator stock.

Dust spray is 52 percent cheaper than liquid spray and it is easier to transport about the orchard. It has no other advantages.

The results of the experiments are sufficiently decisive to warrant the conclusion that dust spray is absolutely ineffective as a preventive of injury from prevailing orchard fungi, and that it is considerably less efficient as an insect remedy than is the liquid method of applying arsenites.

The effort of the orchardist may be best expended in perfecting the preparation and application of the standard Bordeaux mixture combined with arsenites.

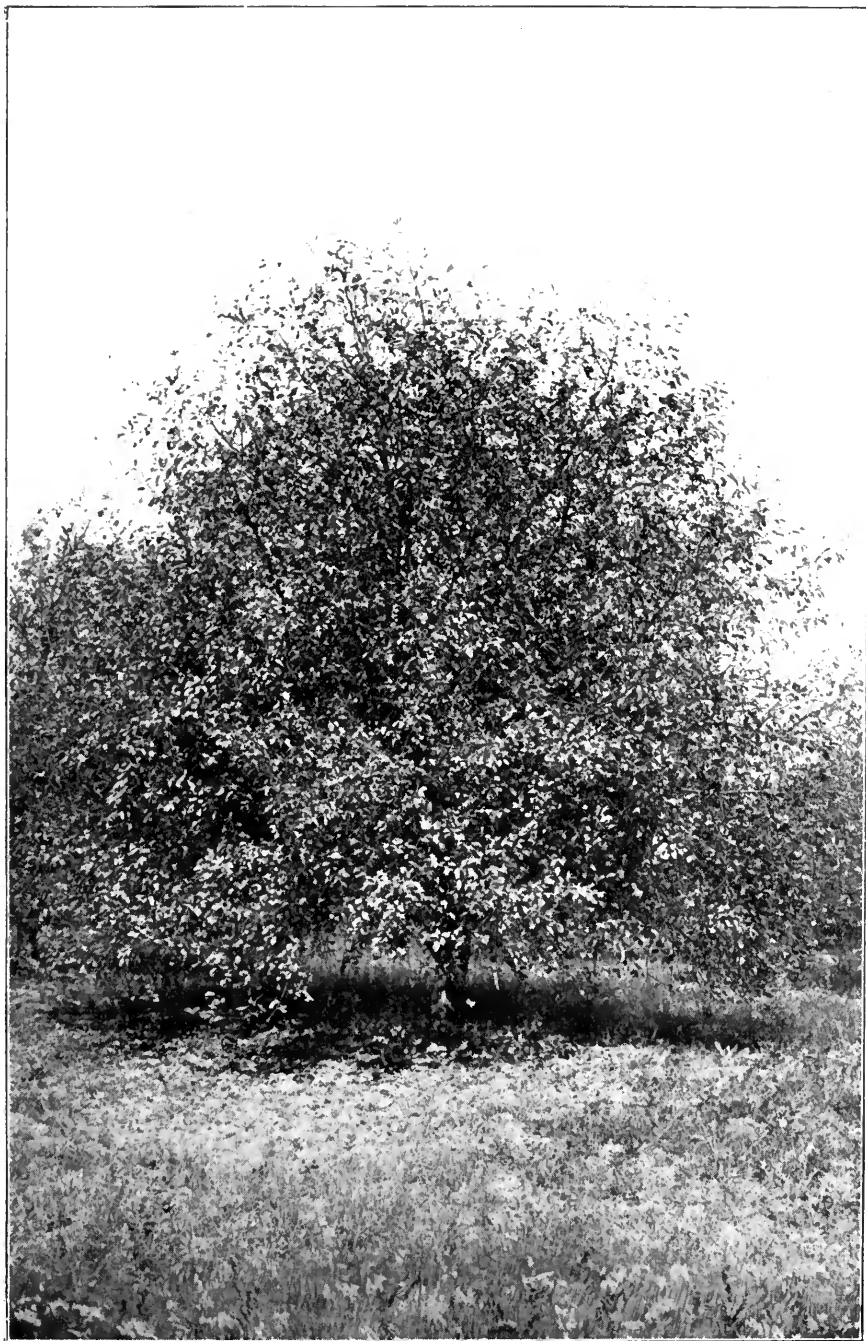


PLATE 8.—WILLOW TWIG SPRAYED SIX TIMES WITH LIQUID BORDEAUX AND PARIS GREEN. FROM PHOTOGRAPH OCTOBER 4, 1905.

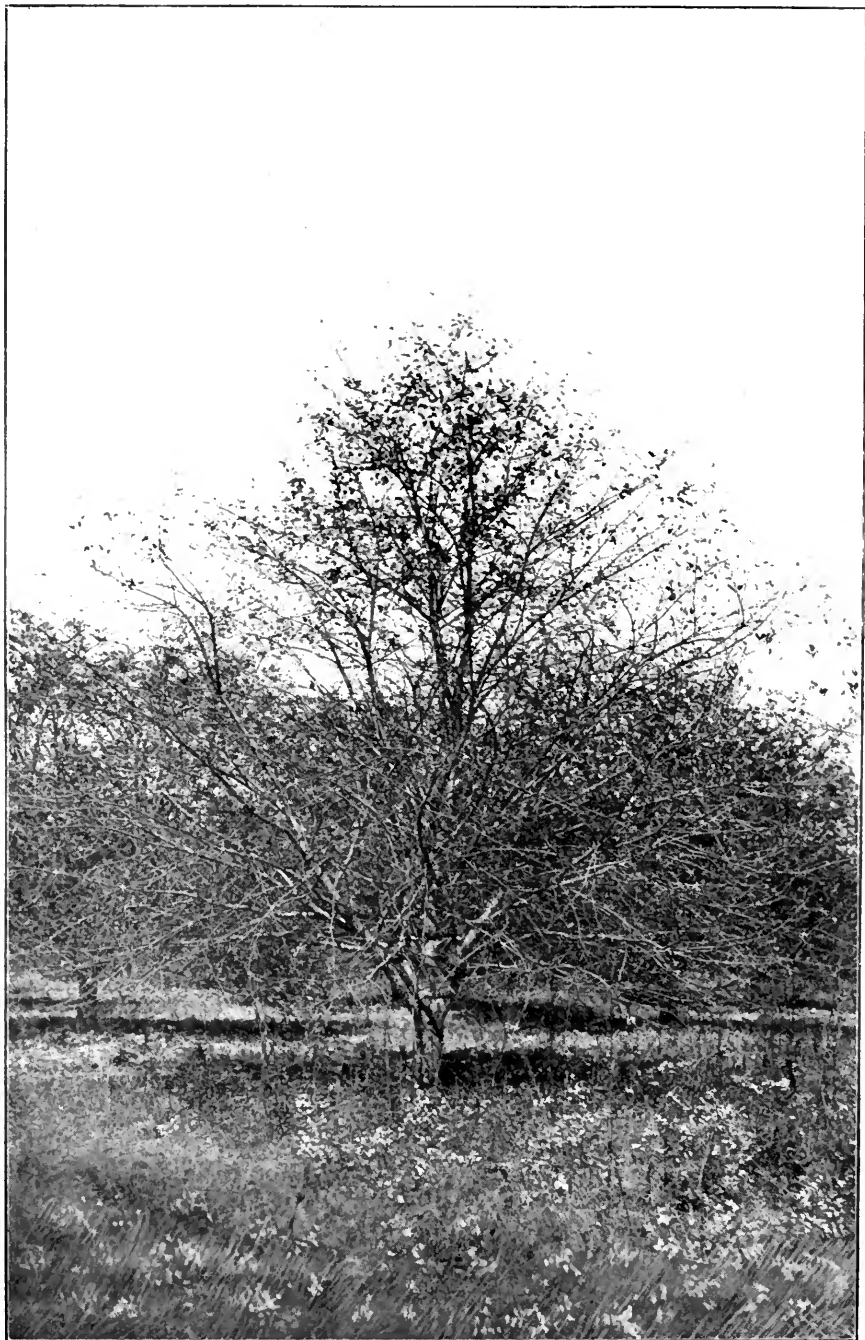
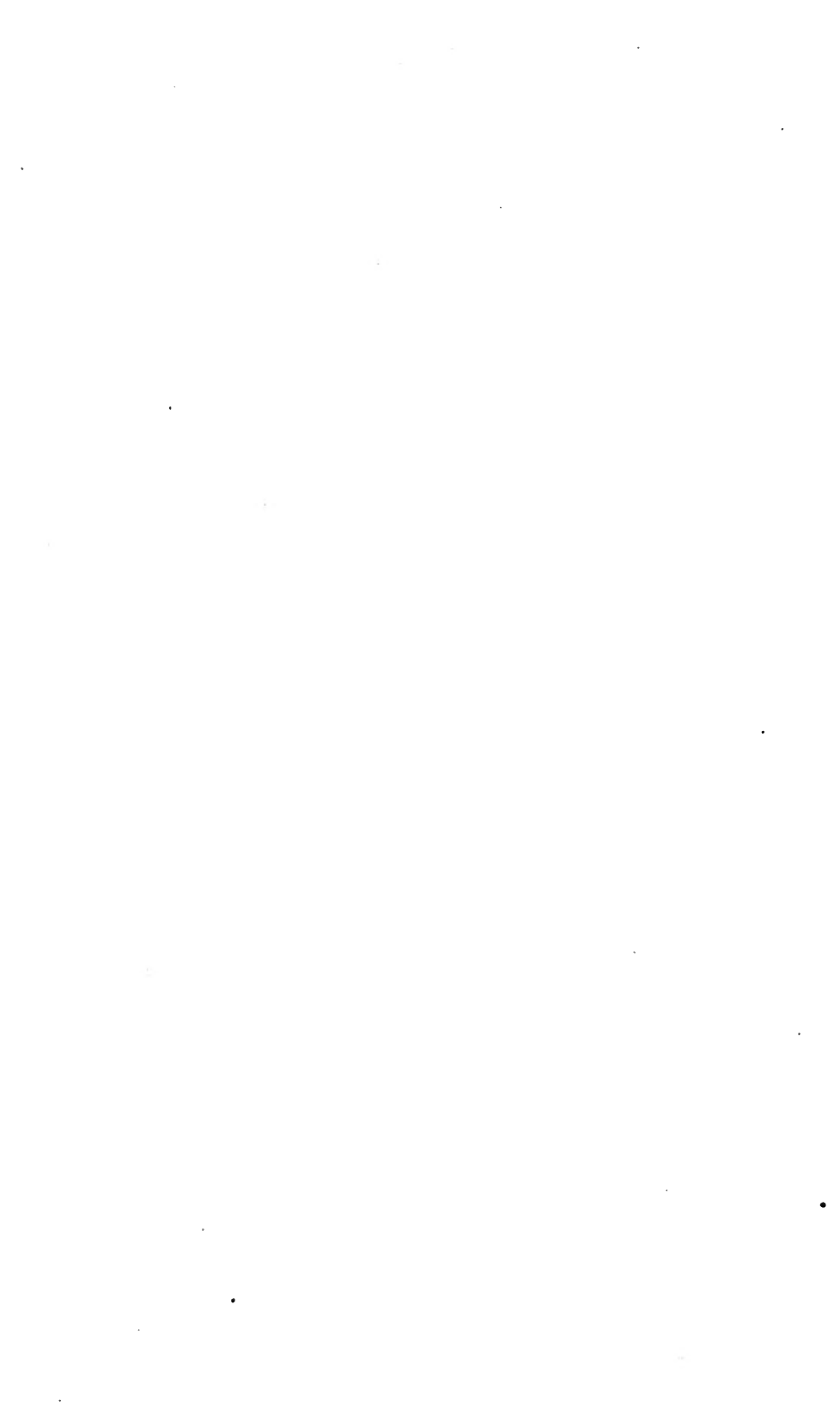
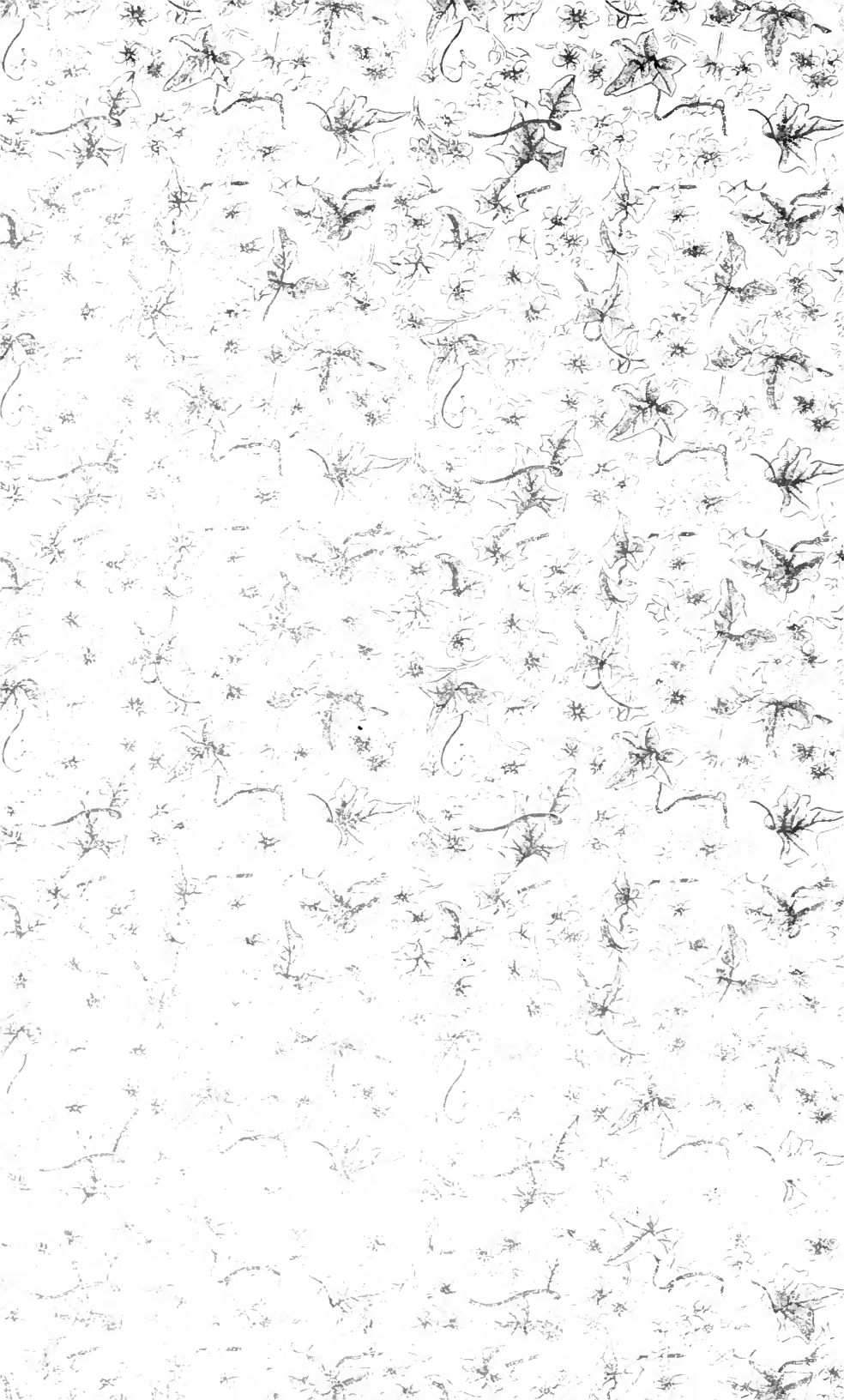


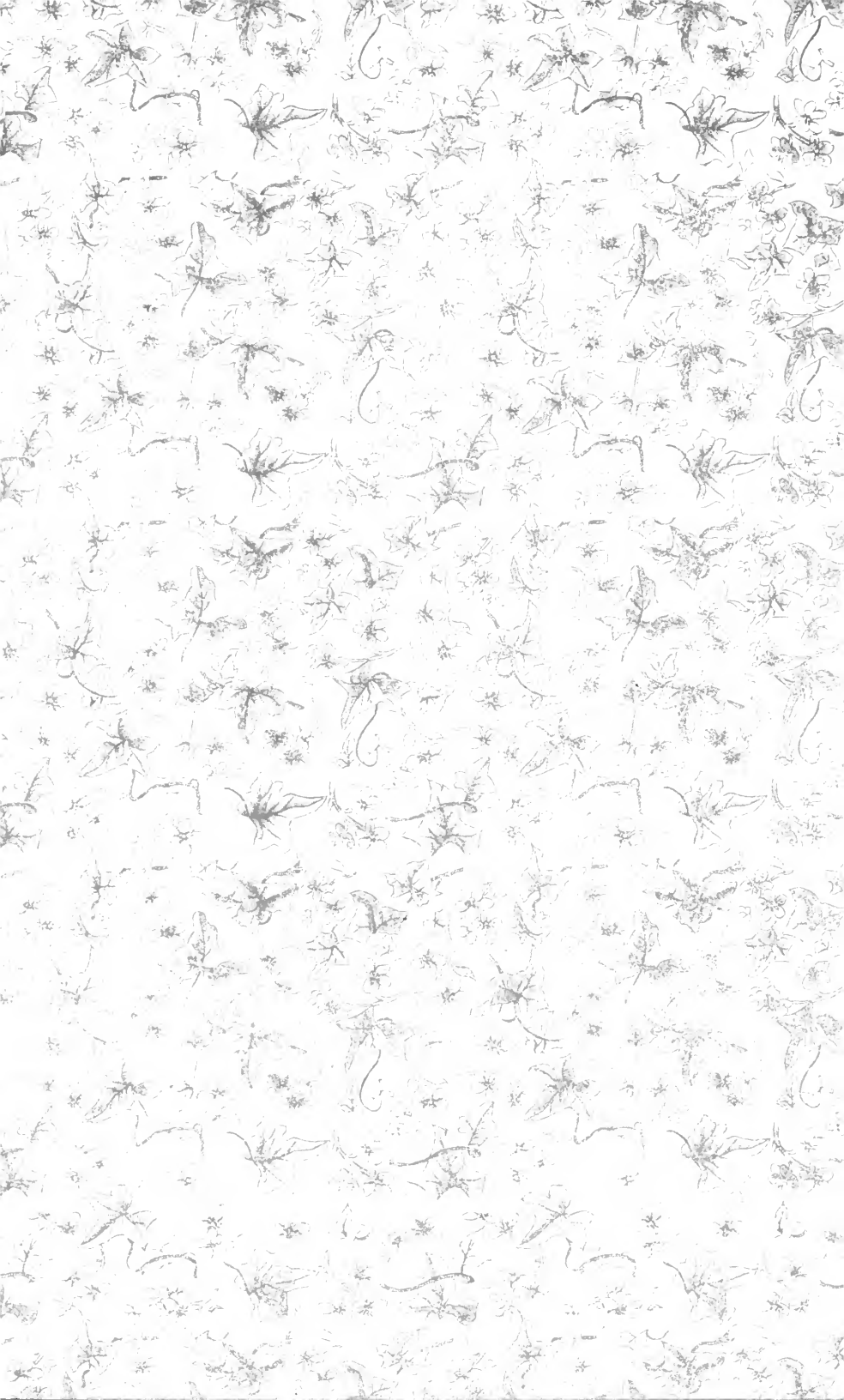
PLATE 9.—WILLOW TWIG NOT SPRAYED. LEAVES NOW ON THIS TREE ARE ALL NEW, FROM BUDS THAT SHOULD HAVE REMAINED DORMANT UNTIL SPRING. FROM PHOTOGRAPH OCTOBER 4, 1905.











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